

AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the subject application.

Claim 1. (Previously Presented) A robot for use with a steerable catheter that includes a thumb control adapted to control a deflection of a distal tip of the catheter and a position sensor, fixed in a vicinity of the distal tip of the catheter, and adapted to generate a position signal, the robot comprising:

an end-effector, adapted to be coupled to the thumb control; and

a controller, adapted to receive the position signal, the position signal being indicative of six dimensions of location and orientation information, the controller being adapted to drive the end-effector to position the distal tip of the catheter at a desired position based on the six dimensions of location and orientation information by manipulating the thumb control.

Claim 2. (Previously Presented) The robot according to claim 1, wherein the controller is adapted to drive the end-effector to deflect the distal tip by moving the thumb control longitudinally with respect to a longitudinal axis of the catheter.

Claim 3. (Previously Presented) The robot according to claim 1,

wherein the catheter includes a handle, adapted to control a roll of the distal tip,

wherein the robot comprises a handle end-effector, adapted to be coupled to the handle,

and

wherein the controller is adapted to drive the handle end-effector to roll the distal tip by manipulating the handle.

Claim 4. (Previously Presented) The robot according to claim 1,

wherein the catheter includes a handle, adapted to advance and withdraw the catheter,
wherein the robot comprises a handle end-effector, adapted to be coupled to the handle,
and

wherein the controller is adapted to drive the handle end-effector to perform, by manipulating the handle, at least one action selected from the list consisting of: advancing the catheter and withdrawing the catheter.

Claim 5. (Previously Presented) The robot according to claim 1, comprising a computer pointing device, adapted to receive an indication of a desired position of the distal tip of the catheter.

Claim 6. (Previously Presented) Apparatus comprising:

a steerable catheter, comprising a thumb control, which is adapted to control a deflection of a distal tip of the catheter and a position sensor, fixed in a vicinity of the distal tip of the catheter, and adapted to generate a position signal; and

a robot, comprising:

an end-effector, adapted to be coupled to the thumb control; and

a controller, adapted to drive the end-effector to deflect the distal tip adapted to receive the position signal, wherein the position signal is indicative of six dimensions of location and orientation information, and, responsive thereto, to drive the end-effector to position the distal tip

of the catheter at the desired position based on the six dimensions of location and orientation information by manipulating the thumb control.

Claim 7. (Currently Amended) ~~Apparatus~~ A robot for use with a steerable catheter that includes controls adapted to control a deflection of a distal tip of the catheter and a position sensor, fixed in a vicinity of the distal tip of the catheter, and adapted to generate a position signal, which controls are generally optimized for manipulation by a human hand, the robot, comprising:

at least one end-effector, adapted to be coupled to at least a portion of the controls; and

a controller, adapted to receive the position signal, wherein the position signal is indicative of six dimensions of location and orientation information, and, responsive thereto, to drive the end-effector to position the distal tip of the catheter at the desired position based on the six dimensions of location and orientation information adapted to drive the at least one end-effector to deflect the distal tip by inducing motion of the portion of the controls that generally mimics motion of the portion of the controls induced when a human hand manipulates the controls.

Claim 8. (Previously Presented) The robot according to claim 7, wherein the controller is adapted to drive the end-effector to deflect the distal tip by moving the portion of the controls longitudinally with respect to a longitudinal axis of the catheter.

Claim 9. (Previously Presented) The robot according to claim 7,
wherein the controls are adapted to control a roll of the distal tip,

wherein the robot comprises a roll end-effector, adapted to be coupled to the controls, and
wherein the controller is adapted to drive the roll end-effector to roll the distal tip by inducing motion of the controls that generally mimics motion of the controls induced when a human hand manipulates the controls.

Claim 10. (Previously Presented) The robot according to claim 7,

wherein the controls are adapted to advance and withdraw the catheter,
wherein the robot comprises a longitudinal motion end-effector, adapted to be coupled to the controls, and
wherein the controller is adapted to drive the longitudinal motion end-effector to perform, by inducing motion of the controls that generally mimics motion of the controls induced when a human hand manipulates the controls, at least one action selected from the list consisting of:
advancing the catheter and withdrawing the catheter.

Claim 11. (Previously Presented) The robot according to claim 7,

comprising a computer pointing device, adapted to receive an indication of a desired position of the distal tip of the catheter.

Claim 12. (Previously Presented) Apparatus comprising:

a steerable catheter, comprising controls adapted to control a deflection of a distal tip of the catheter and a position sensor, fixed in a vicinity of the distal tip of the catheter, and adapted to generate a position signal, which controls are generally optimized for manipulation by a human hand; and

a robot, comprising:
at least one end-effector, adapted to be coupled to at least a portion of the controls; and
a controller, adapted to receive the position signal, wherein the position signal is indicative of six dimensions of location and orientation information, and, responsive thereto, to drive the end-effector to position the distal tip of the catheter at the desired position based on the six dimensions of location and orientation information adapted to drive the at least one end-effector to deflect the distal tip by inducing motion of the portion of the controls that generally mimics motion of the portion of the controls induced when a human hand manipulates the controls.

Claim 13. (Previously Presented) Apparatus comprising:

a steerable catheter, comprising:
a distal tip adapted to be controllably deflectable in no more than two directions for any given rotation of the distal tip, such that a set of all points to which the tip can be deflected at the given rotation forms a deflection curve for the given rotation; and
a position sensor, fixed in a vicinity of the distal tip, and adapted to generate a position signal indicative of six dimensions of location and orientation information;
a robot, adapted to manipulate a proximal end of the catheter; and
a control unit, adapted to:
receive the position signal, and
position the distal tip of the catheter at a target by driving the robot to:
position the distal tip of the catheter in a vicinity of the target, responsive to the position signal based on the six dimensions of location and orientation information,

rotate the proximal end of the catheter in order to cause the distal tip of the catheter to roll to a rotation the deflection curve of which includes the target, the rotation determined responsive to the position signal, and

deflect the distal tip of the catheter along the deflection curve to the target.

Claim 14. (Original) The apparatus according to claim 13, wherein the distal tip is adapted to be controllably deflected in no more than one direction for the given rotation of the distal tip.

Claim 15. (Original) The apparatus according to claim 13, wherein the control unit is adapted to position the distal tip in the vicinity of the target by positioning the distal tip so that the deflection curve of at least one rotation of the distal tip includes the target.

Claim 16. (Original) The apparatus according to claim 13, comprising a computer pointing device, adapted to receive an indication of a position of the target, wherein the control unit is adapted to drive the robot to position the distal tip at the position of the target, responsive to the position signal.

Claim 17. (Cancelled)

Claim 18. (Previously Presented) Apparatus comprising:

a steerable catheter having a distal tip, the catheter comprising a position sensor, fixed in a vicinity of the distal tip, and adapted to generate a position signal indicative of six dimensions of location and orientation information;

a robot, adapted to be coupled to a proximal end of the catheter; and

a control unit, adapted to:

- drive the robot to apply rotation to the proximal end of the catheter,
- receive the position signal,
- responsive to the six dimensions of location and orientation information of the position signal, determine a roll of the distal tip of the catheter, and
- responsive to a determination that the roll lags the rotation, drive the robot to move a portion of the proximal end of the catheter.

Claim 19. (Original) The apparatus according to claim 18, wherein the control unit is adapted to drive the robot to move the portion of the proximal end of the catheter to perform at least one action selected from the list consisting of: straightening the distal tip and deflecting the distal tip.

Claim 20. (Original) The apparatus according to claim 18, wherein the control unit is adapted to drive the robot to move the portion of the proximal end of the catheter to effect translational back and forth motion of the distal tip.

Claim 21. (Original) The apparatus according to claim 18, wherein the control unit is adapted to drive the robot to move the portion of the proximal end of the catheter to perform at least one action selected from the list consisting of: advancing the distal tip and withdrawing the distal tip.

Claim 22. (Cancelled)

Claim 23. (Original) The apparatus according to claim 18, wherein the control unit is adapted to move the portion of the proximal end of the catheter to jiggle the distal tip.

Claim 24. (Original) The apparatus according to claim 23, wherein the control unit is adapted to jiggle the distal tip by rotating the proximal end of the catheter.

Claims 25-34. (Cancelled)

Claim 35. (Previously Presented) A method for use with a steerable catheter having a distal tip adapted to be controllably deflectable in no more than two directions for any given rotation of the distal tip, such that a set of all points to which the tip can be deflected at the given rotation forms a deflection curve for the given rotation, the method comprising:

receiving a position signal indicative of six dimensions of location and orientation information from a vicinity of the distal tip of the catheter; and

robotically positioning the distal tip of the catheter at a target by:

robotically positioning the distal tip of the catheter in a vicinity of the target, responsive to the six dimensions of location and orientation information of the position signal,

robotically rotating the proximal end of the catheter in order to cause the distal tip of the catheter to roll to a rotation the deflection curve of which includes the target, the rotation determined responsive to the six dimensions of location and orientation information of the position signal, and

robotically deflecting the distal tip of the catheter along the deflection curve to the target.

Claim 36. (Original) The method according to claim 35, wherein robotically positioning the distal tip in the vicinity of the target comprises robotically positioning the distal tip so that the deflection curve of at least one rotation of the distal tip includes the target.

Claim 37. (Original) The method according to claim 35, comprising receiving an indication of a position of the target, wherein robotically deflecting the distal tip comprises robotically deflecting the distal tip to the position of the target, responsive to the position signal.

Claim 38. (Cancelled)

Claim 39. (Previously Presented) A method for use with a steerable catheter having a distal tip and a proximal end, the method comprising:

- robotically rotating the proximal end of the catheter;
- receiving a position signal indicative of six dimensions of location and orientation information from a vicinity of the distal tip of the catheter;
- responsive to the position signal, determining a roll of the distal tip; and
- responsive to a determination that the roll lags the rotation, robotically moving a portion of the proximal end of the catheter.

Claim 40. (Original) The method according to claim 39, wherein robotically moving the portion of the proximal end of the catheter comprises robotically performing at least one action selected from the list consisting of: straightening the distal tip and deflecting the distal tip.

Claim 41. (Original) The method according to claim 39, wherein robotically moving the portion of the proximal end of the catheter comprises robotically translating the distal tip back and forth.

Claim 42. (Original) The method according to claim 39, wherein robotically moving the portion of the proximal end of the catheter comprises robotically performing at least one action selected from the list consisting of: advancing the distal tip and withdrawing the distal tip.

Claim 43. (Cancelled)

Claim 44. (Original) The method according to claim 39, wherein robotically moving the portion of the proximal end of the catheter comprises robotically jiggling the distal tip.

Claim 45. (Original) The method according to claim 44, wherein robotically jiggling the distal tip comprises robotically rotating the proximal end of the catheter.